



CLIMATE RESILIENCE THROUGH NON-TIMBER FOREST PRODUCTS: ADAPTIVE STRATEGIES FOR TRIBAL COMMUNITIES

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ABSTRACT

Climate resilience is essential for the sustainability of tribal communities, especially considering the increasing impacts of climate change. In this context the study aims to investigate how Non-Timber Forest Products (NTFPs) can promote climate resilience within tribal communities. By utilizing traditional knowledge and adaptive strategies, tribal communities can improve their ability to cope with and adjust to changing climate conditions. The paper highlights various adaptive strategies, such as sustainable harvesting techniques, diversification of NTFPs, and the integration of agroforestry practices. These strategies not only contribute to environmental conservation but also ensure livelihood security. Case studies from different tribal regions demonstrate successful implementation of these strategies, providing valuable insights into best practices and lessons learned. The findings emphasize the importance of supportive policy frameworks and community participation to guarantee the long-term sustainability and climate resilience of NTFP-based livelihoods in tribal areas. Furthermore, the study underscores the significance of conserving biodiversity as a crucial element of climate resilience strategies. The research advocates for an integrated approach that combines climate-smart agriculture with NTFP management to strengthen the adaptive capacity of tribal communities. Overall, this comprehensive examination of NTFPs and climate resilience highlights the potential of NTFPs as a sustainable resource that supports both ecological balance and economic stability for tribal populations in the face of climate change.

KEYWORDS: Adaptive Strategies, Agroforestry, Climate Resilience, Livelihood Security, Non-Timber Forest Products (NTFPs), Sustainable Harvesting

INTRODUCTION

Climate change poses a significant threat to biodiversity, ecosystems, and the livelihoods of communities that depend on natural resources, particularly tribal populations. These communities rely on Non-Timber Forest Products (NTFPs) such as fruits, nuts, resins, and medicinal plants for food, medicine, and economic activities. NTFPs are crucial for their socio-economic well-being and adaptive strategies in the face of climate change. However, changing climate patterns, including temperature fluctuations, altered precipitation, and more frequent extreme weather events, are affecting the availability and quality of NTFPs, threatening the sustainability of these livelihoods. To enhance the resilience of tribal communities, it is essential to promote sustainable harvesting practices that prevent resource depletion and habitat degradation. Integrating agroforestry practices, which combine trees and shrubs with crops and livestock, can also improve climate resilience by enhancing soil health, biodiversity, and carbon sequestration. Additionally, combining traditional knowledge with scientific research can lead to more effective climate adaptation and mitigation strategies. This study aims to assess the impact of climate change on NTFPs, promote sustainable harvesting, integrate agroforestry practices, and merge traditional knowledge with scientific research to develop strategies that support tribal communities in adapting to and mitigating the effects of climate change, ultimately fostering sustainable livelihoods and resilient ecosystems. Singh et al., (2017) Climate change affects natural and anthropogenic processes,

including material and water cycles, forest growth or forestry, and farming. Further, it affects livelihoods sustained by rural residents who are engaged in production activities, such as the production of non-timber forest products (NTFPs), which is related to sustainable forest management (SFM). These effects occur within feedback systems, especially where production is interconnected with natural local and global processes. Wheeler et al., (2021). The climate change crisis is a curse that poses a big threat to the human race, as identified by the IPCC. In a report by UNDP, it was clear that climate change is hitting the developing economies the hardest, and it's likely going to reverse the development made in the last decade. Additionally, the SDGs that are in their earlier stages of implementation are also in jeopardy of collapse. Climate Change is a many sided phenomenon. The rich and the poor, different social classes and other such groups cannot claim to be safe from the impacts of climate change. While factors dominate in this case yet, unusual weather patterns have an unpredictable timetable and geography, they can occur at any place at any time. This is not to downplay the concerns expressed especially by indigenous inhabitants who experience the distinct effects of climate change. There are clear differences in the prevailing vulnerabilities among various groups of people. Tripp & Norgaard, (2016). In countless communities around the world, non-timber forest products (NTFPs) play an essential role in sustaining ecosystems and livelihoods (David et al., 2019; Debrot et al., 2020; Karki, 2000). The term NTFPs refers to a wide variety of plant and animal-based resources harvested from forests, unlike timber, which

revolves around the extraction of wood. Sharma et al.,(2015). Distributed under a Creative Commons CC BY license. And other essentials that local communities require for subsistence are supplied by NTFPs. Climate change and variability is not new, and many societies have adeptly coped with and adapted to climate variability and many other stressors during the past centuries. Mertz et al.,(2009a). Climate change is considered to be one of the major threats to sustainable development because of its effects on health, infrastructure, agriculture and food security, and forest ecosystem (IPCC, 2007a). McCarthy et al. (2001). India's agroforestry helps in fulfilment of the target set by the Indian Council of Agricultural Research of increasing forest cover from the current 23% of land area to 33%. During its deliberations on India's green cover the Task from Greening India for Livelihood Security and Sustainable Development (Planning Commission: 2001) has recommended that irrigated 10 million ha and 18 million ha of rain-fed land should be brought under agroforestry systems. Third Assessment Report on Climate Change by the Intergovernmental Panel on Climate Change. Brown et al., (1996). has understood the possibilities of agroforestry in providing solution to a variety of problems and creating a range of economic, environmental and socioeconomic benefits. The annual mean carbon sequestration potential of agroforestry systems is estimated. Van Ardenne et al. (2003). Other environmental benefits include the provision of food, the security of land use, increased farm revenue, the restoration and maintenance of carbon and biodiversity above and below ground, and the conservation of water resources and soil. Aerosystems can also be designed as a means for the adaptation of communities and households to the local or the global change.

OBJECTIVES

- Assessing the Impact of Climate Change on NTFP Availability and Quality
- Promoting Sustainable Harvesting Practices
- Integrating Agroforestry Practices for Enhanced Climate Resilience
- Integrating Traditional Knowledge with Scientific Research
- To strategies how NTFPs can contribute toward adaptation and mitigation of climate change

METHODOLOGY

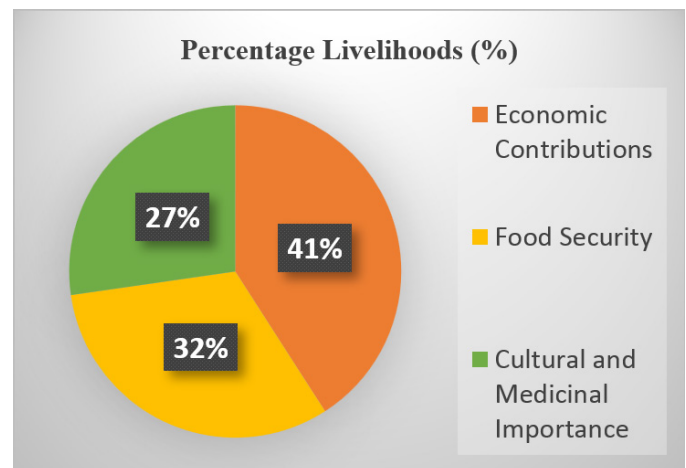
The Study focuses on a comprehensive examination of secondary data sourced from various book national and international journal and publications on various websites dealing and different aspects of Climate Resilience through Non-Timber Forest Products Tribal Communities.

Importance of NTFPs for Tribal Livelihoods:

Non-Timber Forest Products (NTFPs) are essential and therefore significant in the preservation of the global tribes communities. These products are obtained from the forest without the felling of trees and include nuts, fruits, medicinal plants, honey, resins and even bamboo. For indigenous communities, especially in the Gajapati district of India, NTFPs are the only means of commodity exchange and food as well as cultural heritage treasures. For instance, The Saura and Kandha tribes use Non-Timber forest Products in their livelihood and

get about 60 percent of their total income from the products. Seasonal products like sale seeds, tamarind and mahua flowers ensure recurrent income while some herbs and plants provide traditional medicine. Also, women contribute in a significant way to the gathering and processes of NTFPs and thus gender equity in these societies is improved. The application of NTFP's in ESG strategies will guarantee their appropriate use and assist in the preservation of biodiversity. NTFPs can migrate from being a sustenance activity to an economically viable business for tribal households by creating market linkages, value addition structures and facilitating policies. All in all, non-timber forest products complement economic development and the preservation and conservation of the environment and therefore are critical for the sustainable development of the tribe.

1. **Economic Contributions:** Non-Timber Forest Products (NTFPs), such as honey, medicinal plants, bamboo, and resin, play a vital role in boosting household incomes. They also act as safety nets, helping families cope with crop Failures due to unpredictable weather patterns.
2. **Food Security:** Forest fruits, nuts, and tubers serve as important supplementary food sources during periods of low agricultural production. These resources are particularly crucial in times of climate-induced crises, such as droughts.
3. **Cultural and Medicinal Importance:** Many NTFPs carry cultural significance and are essential components of local rituals and traditions. Medicinal plants offer affordable healthcare options for remote tribal populations.



Source: Computed by Author using SPSS

Graph 1

This pie chart visualizes the percentage distribution of the contributions of Non-Timber Forest Products (NTFPs) to tribal livelihoods. The chart is divided into three main categories: Economic Contributions (41%): This segment highlights the role of NTFPs in boosting household incomes and serving as safety nets during periods of crop failure or economic hardship. Food Security (32%): This portion emphasizes the importance of NTFPs like forest fruits, nuts, and tubers as supplementary food sources, particularly during times of agricultural shortages or climate-induced crises. Cultural and Medicinal

Importance (27%): This category reflects the value of NTFPs in local cultural traditions and rituals, as well as their role in providing affordable healthcare through medicinal plants. The percentages represent the relative significance of each category in supporting the livelihoods of tribal communities.

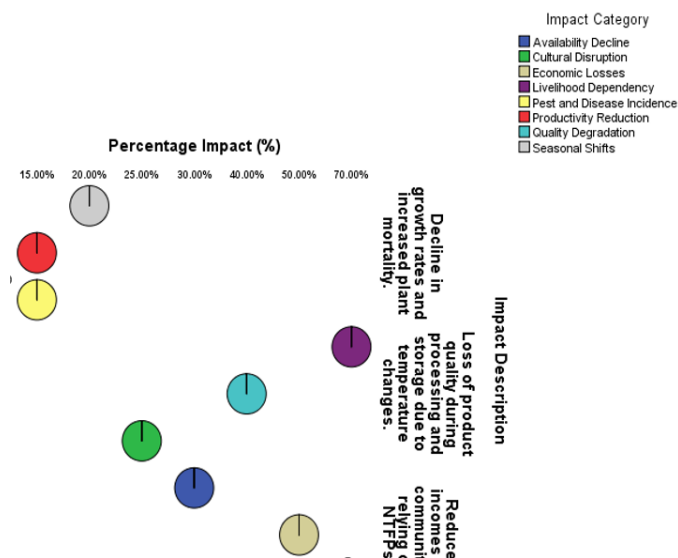
Climate Change Impacts on NTFPs:

Climate change directly affects non-timber forest products (NTFPs) by altering ecosystems, shifting seasonal patterns, and increasing vulnerability to extreme weather events. Rising temperatures and unpredictable rainfall impact the flowering, fruiting, and growth cycles of NTFP-producing species, such as bamboo, tendu leaves, and medicinal plants. For example, prolonged droughts can reduce forest cover, while unseasonal rains disrupt harvest schedules, resulting in decreased yields and resource availability. Extreme weather events, including cyclones and floods, can damage forests and degrade NTFPs. These disturbances often lead to pest infestations and disease outbreaks, further harming the health of forest ecosystems. Additionally, increased humidity and heat can adversely affect the storage and processing of products like honey and forest oils, diminishing their market value and economic potential.

Graph

PIE=COUNT BY Impact Category

PANEL COLVAR=Percentage Impact COLOP=CROSS
ROWVAR=Impact Description ROWOP=CROSS.



Source: Computed by Author using SPSS

Graph 2

This chart visually illustrates the percentage impacts of climate change on various aspects of Non-Timber Forest Products (NTFPs). It categorizes these impacts into several areas, including Availability Decline, Cultural Disruption, Economic Losses, Livelihood Dependency, Pest and Disease Incidence, Productivity Reduction, Quality Degradation, and Seasonal Shifts. Each category is represented by a distinct colour in The legend. The horizontal axis (x-axis) displays the Percentage Impact, ranging from 15% to 70%, with each impact category marked by a bubble corresponding to its percentage. The vertical axis (y-axis) offers descriptions of the impacts, such as “Decline

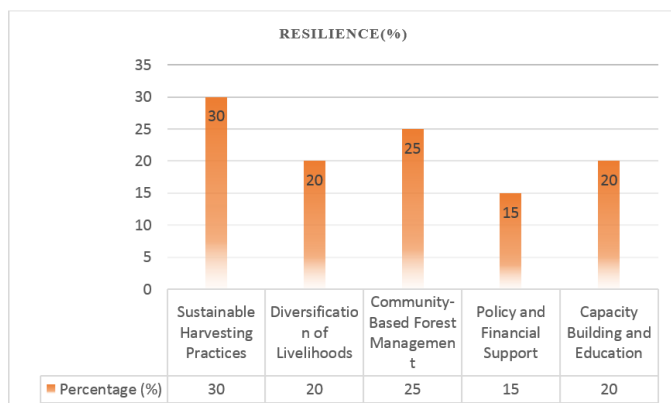
in growth rates and increased plant mortality,” “Loss of product quality during processing and storage due to temperature changes,” and “Reduced incomes for Communities relying on NTFPs.” The bubbles indicate the relative percentage impact of each category, positioned horizontally at the respective percentage impact, with colours matching the legend to identify specific impact categories. Livelihood Dependency shows the highest impact at 70%, highlighting the vulnerability of tribal communities to climate change due to their reliance on NTFPs. Economic Losses and Quality Degradation are also significant, affecting 50% and 40% of the communities, respectively. While Seasonal Shifts and Productivity Reduction have relatively lower impacts, they still pose challenges to the sustainability of NTFPs.

Adaptive Strategies for Resilience:

To address these challenges, tribal communities and policymakers must implement adaptive strategies that enhance resilience. One effective approach is to promote climate-resilient non-timber forest product (NTFP) species, such as drought-tolerant bamboo and pest-resistant medicinal plants, which can help sustain productivity despite changing climatic conditions. Additionally, diversifying NTFP-based livelihoods through agroforestry systems can reduce reliance on single resources and mitigate risks. Traditional ecological knowledge (TEK) provides valuable insights into sustainable resource management, as tribal communities have historically used indigenous practices to manage forests and adapt to environmental changes. By integrating TEK with scientific innovations such as GIS-based forest monitoring and climate-smart agriculture robust solutions can be developed. Policy interventions, including capacity-building programs, financial incentives for sustainable harvesting, and Environmental Social Governance (ESG) frameworks, are essential. These measures can empower tribal communities to protect their forests while enhancing their socio-economic resilience. By adopting these strategies, tribal communities can turn climate challenges into opportunities, ensuring the sustainable use of NTFPs while preserving their cultural heritage and livelihoods for future generations.

- Sustainable Harvesting Practices:** Train tribal communities in sustainable methods to prevent the overexploitation of non-timber forest products (NTFPs). Promote agroforestry systems that integrate NTFPs with agricultural crops.
- Diversification of Livelihoods:** Encourage value addition to NTFPs through processing and branding. Promote alternative income sources, such as eco-tourism, linked to forest resources.
- Community-Based Forest Management:** Strengthen local institutions for collective and equitable forest management. Implement participatory monitoring systems to track climate impacts and resources availability.
- Policy and Financial Support:** Ensure tribal access to climate adaptation funds and insurance schemes. Formulate policies that secure forest rights and incentivize the sustainable trade of NTFPs.
- Capacity Building and Education:** Conduct workshops

on climate-resilient farming and NTFP management. Raise awareness about the impacts of climate change and potential mitigation measures.



Source: Computed by Author using SPSS

Graph 3

This bar chart represents the distribution of percentages across various adaptive strategies for resilience. Each strategy is allocated a specific percentage based on its importance or focus: Sustainable Harvesting Practices (30%): This strategy has the highest focus, emphasizing the need for training in sustainable harvesting methods and promoting agroforestry systems. Community-Based Forest Management (25%): The second-highest priority, highlighting the importance of strengthening local institutions and participatory monitoring systems for managing forest resources collectively. Diversification of Livelihoods (20%): This strategy promotes adding value to NTFPs, developing alternative income sources like eco-tourism, and is equally prioritized alongside capacity building. Capacity Building and Education (20%): Focuses on conducting workshops and raising awareness about climate-resilient practices and the impacts of climate change. Policy and Financial Support (15%): While critical, this strategy has the lowest percentage, emphasizing ensuring access to climate adaptation funds and securing forest rights.

CONCLUSION

The relationship between non-timber forest products (NTFPs) and tribal communities highlights the important role these resources play in promoting climate resilience. Climate change poses challenges to the availability and quality of NTFPs, making it necessary to develop adaptive strategies to sustain tribal livelihoods. This study emphasizes the significance of promoting sustainable harvesting practices to mitigate the negative effects of climate change. By adopting responsible harvesting techniques, tribal communities can ensure the long-term viability of NTFPs, thus preserving their economic and cultural importance. Integrating agroforestry practices emerges as a crucial strategy for enhancing climate resilience. Agroforestry not only diversifies income sources but also improves soil health and biodiversity, creating a buffer against climate fluctuations. The combination of traditional knowledge and scientific research forms the foundation of effective climate resilience strategies. Tribal communities possess a wealth of indigenous knowledge, which, when integrated

with modern scientific approaches, can lead to innovative solutions for sustainable NTFP management. Furthermore, collaborative efforts between researchers, policymakers, and tribal communities are essential in addressing the multifaceted challenges posed by climate change. Policies should prioritize the protection of forest ecosystems, support sustainable livelihoods, and foster the participation of tribal communities in decision-making processes. By promoting a holistic approach that combines traditional wisdom with scientific advancements, we can develop resilient systems that not only preserve NTFPs but also empower tribal communities to thrive in the face of climate change. In conclusion, the sustainable management of NTFPs through adaptive strategies, sustainable harvesting, and agroforestry practices, combined with the integration of traditional and scientific knowledge, is key to building climate-resilient tribal communities. This holistic approach ensures the conservation of biodiversity, supports livelihoods, and enhances the overall resilience of both the ecosystem and its inhabitants.

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